



# International Code Council

## ICC IS-3DACT Committee – Meeting Minutes #6

March 15, 2024 – 10:00 AM PST

### 1. Welcome and opening remarks

*Staff Secretariat, Melissa Sanchez called the meeting to order at 10:02 am PST and welcomed all committee members, invited parties, and ICC staff.*

*Ms. Sanchez then went on to note the committee must adhere to the ICC Code of Ethics, which states that those participating in ICC activity must adhere to the highest ethical conduct, with the purpose of the protection of the health, safety and welfare of the public by creating safe buildings and communities. In addition, Section 5.1.10 in Council Policy #7 is in effect and any committee member with a conflict of interest must withdraw from participating in discussion or vote on the matter in which they have an undisclosed interest. Lastly, Council Policy #50 outlines ICC Antitrust guidelines, which indicates the committee meetings are not intended for discussion of pricing and marketing topics.*

### 2. Quorum and Attendance

*Ms. Sanchez called the roll of the IS-3DACT with the following members registering attendance. Ms. Sanchez noted there was enough for a quorum.*

NAME	IS-3DACT COMMITTEE MEETING					
	#1 10/20/23	#2 11/17/23	#3 12/15/23	#4 1/12/24	#5 2/9/24	#6 3/15/24
Jared Brewe [A]	x	X	X	X	-	X
Gabriel Carrera [D]	x	X	X	-	X	X
Bora Gencturk [C]	x	X	X	X	X	X
Rory Hamaoka [H]	x	X		X	X	X
Werner Hellmer[H]	x	X	X	-	X	X
Maryam Hojati [D]	x	X		-	X	X
Berok Khoshnevis [D]	x	X	X	X	-	
Jeff Martin [A]	x		X	X	-	X
Doug Mayer [H]	x		X	X	X	
Paul Messplay [H]	x	X	X	-	X	X
Adil Tamimi [D]				X	-	X
<b>Bing Tian [A]</b>	x	X	X	X	X	X
<b>TOTAL</b>	12/13	10/13	10/13	9/13	8/12	10/12

*Interested parties in attendance included Stephan Mansour (ASTM), Daniel Galvez Moreno (ICON), Abdul Peerzada (Quikcrete), Rex Donahey (ACI), Richard Reeves (Werner Construction), Lucas Laughery (ICON), Robert Devine (Wiss, Janney, Elstner Associates), Muhammad Shakeel Akhtar (Parsons), Mahmut Ekenel (ACI)*

### 3. Approval of Agenda

*Chair Mr. Bora Gencturk asked for a motion for approval of the agenda. Mr. Paul Messplay motioned for approval. Mr. Werner Hellmer seconded the motion. The agenda was unanimously approved.*

### 4. Approval of Previous Meeting Minutes

*Mr. Gencturk asked for a motion for approval of the previous meeting minutes. Mr. Bing Tian motioned. Mr. Rory Hamaoka seconded. The previous meeting minutes were unanimously approved.*

### 5. Update on Work Groups

#### a. Materials Work Group (Bing Tian)

*Mr. Tian relayed that the Materials Work Group met several times. The group managed to draft Chapters 3 and 5 but found that some topics needed to be addressed by the full committee.*

#### b. Structural Work Group (Jared Brewe)

*Mr. Jared Brewe also relayed that the Structural Working Group met and also found that some topics needed to be discussed.*

### 6. Additional discussion of Initial Draft

*Mr. Tian started the conversation off requesting more information about workability, slump and setting time.*

*Mr. Gencturk inquired about the mixing method. He commented that mixing methods can differ, and that the testing lab might not have the same mixer as the manufacturer. Mr. Tian responded that it was written into the standard to follow ASTM C305. Mr. Daniel Moreno pointed out the text about mixing methods is in Section 303.*

*Mr. Tian asked the committee about the setting time and if it should be optional. Mr. Jeff Martin asked why have it at all if it's optional. Mr. Gencturk commented some manufacturers rely on setting time and this section is meant to give guidance on how to do the procedure.*

*Then Mr. Tian asked about what the minimum compressive strength should be. Mr. Brewe said to base it off of ACI 318 which gives 2500 psi as a minimum. Mr. Moreno agreed on the 2500 psi value because it is costlier to achieve higher strengths. Mr. Gencturk also agreed on the 2500 psi value for a minimum and also suggested specifying a maximum strength like ACI 318 does.*

*Mr. Tian then brought up sample size. He said the Materials Work Group agreed on a 3x6 cylinder. Ms. Maryam Hojati suggested a larger size to accommodate larger aggregates. Mr. Gencturk agreed it makes sense to include larger cylinder sizes and suggested that sample sizes could be determined by the coarse aggregate size.*

*Then Ms. Hojati asked how to relate the strength of the cylinders to the printed product, which could differ. Mr. Tian responded that Chapter 3 is only considering the material itself in the lab based on ASTM current standards. Mr. Gencturk agreed that Chapter 3 is about the material itself in the lab and any differences between the printed material should be*

addressed in Chapter 5. He suggested this could be done by providing an acceptable range for the material printed in the lab. For example, 3000 +/- 500 psi for the minimum strength.

Mr. Tian asked about the requirement for the Modulus Elasticity if the minimum compressive strength is set to 2500 psi. Mr. Brewe conveyed he didn't think the MoE was necessary because he doesn't believe these were MoE controlled elements. Mr. Lucas Laughery agreed. Mr. Gencturk suggested to refer to ACI to calculate the MoE and not specify a range.

The next topic Mr. Tian brought to discussion was on max allowable interlayer time and interlayer bond strength. Mr. Tian asked if it was okay if the manufacturer printed the material and had a 3<sup>rd</sup> party test it. Mr. Moreno shared on screen ICON's method for determining interlayer bond strength. Mr. Gencturk commented that this only took care of the tension bond but failed to address the shear bond. He asked about including a test for shear bond strength. Mr. Brewe said the difficulty is there are no standardized tests for shear bond strength. Mr. Gencturk countered that there were non-standardized tests that addressed shear bond strength. Mr. Abdul Peerzada agreed that shear was important. Mr. Gencturk asked if shear bond could be completely ignored. Mr. Laughery said it was reasonable to leave shear to the structural engineer and suggested if shear bond was not used in calculations, testing may not be necessary. Mr. Gencturk said shear could be more of a durability issue. Ms. Hojati brought up masonry standards as a reference to consider. Mr. Brewe asked Mr. Tian if interlayer bond strength was a pre-qualification test and Mr. Tian said yes. Mr. Stephen Mansour stated that masonry standards ASTM E519 and E518 address shear and material bond strength.

Regarding interlayer bond strength, Mr. Mahmut Ekenel commented that AC509 was written such that bond strength is a design issue and should be left to the design engineer. He suggested that it was premature to come up with a number because interlayer bond strength depends on the design procedure. Mr. Gencturk agreed. Mr. Moreno commented that interlayer time is a material property. Mr. Tian commented a minimum strength is needed. Mr. Peerzada commented the minimum strength changes depending on the industry. For example, the batching industry has different numbers. Mr. Tian asked what the standard deviation was in ICON's method. Mr. Moreno said it was high, never under 50 psi. Mr. Tian said that Quikcrete has a similar range. Mr. Moreno said that is why the values stated in the standard are a minimum and not a range. Mr. Gencturk asked about the size of the sample as it is not listed in the text. Bing said it was not included yet, but the working group is considering below 2 inches. Both ICON's method and Quikcrete's method with a coupon are not standardized. Mr. Peerzada stated that the ASTM standard for interlayer bond strength must be modified in terms of sample size, substrate size, including the details for the depth, the number of layers, the size of cutout. Additionally, the shear bond strength needs to be included. Mr. Gencturk agreed.

Moving the discussion on, Mr. Tian stated that the shrinkage requirement was set for 0.05% for concrete and 0.15% for mortar. Everyone seemed to be in agreement with this requirement.

For flexural strength Mr. Tian asked if ASTM C1550 was a good method. Mr. Adil Tamimi agreed that it was. Mr. Gencturk suggested language about the types of fibers be included. Mr. Ekenel asked why C1550 (the round panel method) which requires a toughness value is

to be used. Mr. Peerzada commented that this was added because this is a test done with FRC and he is not aware of other methods. Mr. Ekenel said he will do some research and reach out next week about this. Ms. Hojati asked about ASTM C348-21. Mr. Peerzada responded that this was for mortar, but something for concrete is needed.

Moving onto Chapter 5, Mr. Tian asked if a mockup wall is needed for Structural QC requirements. A discussion proceeded on whether a mockup wall is needed for dimensional stability, interlayer bond strength, and/or workability assessment. Mr. Rex Donahey questioned the practicality and purpose of the slump test. He raised concerns that the slump test is an indirect means to test workability and is a nuisance for the contractor. He asked about using the size of the extruded form relative to the extrusion pipe. Mr. Tian and Mr. Tamimi agreed. Mr. Tamimi said workability is based on how the mortar flows past the nozzle and slump did not make sense. Mr. Moreno countered and said that interlayer bond strength is related to workability and there needs to be a way to monitor the workability. Mr. Tian suggested that a mockup wall would be better for addressing the workability requirements. He commented that a similar procedure is done with shotcrete, where a mock panel is shot onsite and then cored, and petrographic analysis used for determination of air content. Mr. Moreno disagreed with a mockup wall, suggesting it is too late in the process to determine bond strength. Mr. Tian responded that Chapter 5 is about quality control after printing. Mr. Tamimi agreed with Mr. Tian. Mr. Gencturk asked how restrictive the standard should be regarding dimensional stability and the allowable tolerances for height and width of the extruded material in relation to the nozzle. Mr. Moreno said different manufacturers will have different standards for dimensional stability and the mockup wall is a way to measure interlayer bond strength. This method, however, is costly if required for every print. Mr. Moreno suggested specifying when a mockup wall is needed. Mr. Hellmer asked if not required how the structural capacity of the printed wall can be determined without a mockup wall. He asked if a mockup wall is needed for dimensional stability or just for bond strength.

At this time, Mr. Gencturk moved the meeting to the Structural Work Group discussion.

Mr. Brewe presented Chapter 4. He summarized that the wall is defined to be continuous from the foundation to the roof and that the wall can be printed beads placed next to each other or hollow systems that are filled in. He explained that the Design Criteria is pulled from the IBC and IRC and that since there has not been much work done on beyond seismic design categories A and B categories that the working group is not confident including higher seismic design categories. Mr. Ekenel asked about load combinations and stated that he would check if they are listed in the IRC. Mr. Brewe continued to summarize the chapter, briefly discussing Detailing Requirements – horizontal ties, reinforcement, joints, location and spacing, parapets, durability – and then Engineering Design Provisions such as Effective Structural properties, including minimum contact area between extruded layers. On the topic of Single-wythe walls and double-wythe walls, Mr. Brewe asked if there were any thoughts on the effective contact area or width of wall section. Mr. Laughery asked about the effective width and how it related to QC and if visual confirmation every x-related feet is needed. Mr. Brewe noted that this was a good question to consider. Mr. Brewe then discussed on the last section on Design Methodology and whether concrete design or masonry design is the more appropriate way to design 3d printed walls. Additionally, the section on Connections, Anchorage, Structural Testing Criteria were pulled from AC509 and follow it closely.

7. Next Meeting

*The next meeting is set for April 19, 2024, at 10am PDT.*

8. New Business

*There were no additional items.*

9. Action Items & Summary

*The action items from the meeting were summarized as follows:*

<i>Melissa to email Structural Working group working draft</i>	<i>Ms. Sanchez</i>
<i>Working groups provide drafts by 4/1</i>	<i>Mr. Tian and Mr. Brewe</i>
<i>Robert Devine requested to be added to Structural Working Group</i>	<i>Ms. Sanchez</i>

*With no other questions or comments before the committee Mr. Gencturk moved to adjourn the meeting. Jared motions for adjourning and Werner seconds the motion. The meeting is adjourned at 11:50 am PDT.*